

***Clitopiloides prati* and *Trichopilus lecythiformis* spp. nov. from Australia**

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ABSTRACT—*Clitopiloides prati* (from northeastern Queensland) and *Trichopilus lecythiformis* (from coastal New South Wales) are described as new entolomatoid species based on morphological characters. Morphological similarities are discussed for these and other closely related species. We also provide nuclear ribosomal RNA repeat (nrITS) and large subunit (nrLSU) sequences where obtained

Key words—*Agaricales*, *Basidiomycota*, *Entolomataceae*, taxonomy

Introduction

Agarics are readily recognized as representing *Entolomataceae* (*Agaricales*) by their flesh colored basidiospores that are angular at least in end view; the family has a cosmopolitan distribution and is common in temperate and tropical ecosystems. Within the family, basidiomes exhibit highly diverse morphologies and ecologies. One consequence of this diversity is the acceptance of 1848 species as valid by Kalichman & al. (2020), the second highest of all families classified in the *Agaricales*.

The multigeneric classification of *Entolomataceae* utilized in this paper follows Largent (1994). The reasons for adopting this approach are detailed in Largent (2020), but important points are reiterated here: a) the basionym for nearly every genus in Largent (1994) is identical to the infrageneric basionyms in Romagnesi & Gilles (1979), Noordeloos (1992, 2004), and Noordeloos & Gates (2012); (b) it is relatively easy to distinguish the different genera visually

using this classification in the field; c) although a comprehensive classification based on a phylogenetic and morphological approach in *Entolomataceae* is not yet universally accepted, many segregate entolomatoid genera are supported by phylogenetic analysis (Karstedt & al. 2019, He & al. 2019).

Australian field investigations from 2009–12 within northeastern Queensland's Wet Tropics Bioregion and from 2010–12 in the temperate rainforests of central New South Wales have uncovered several novel species in the *Entolomataceae* (Largent & Abell-Davis 2011; Largent & al. 2011a,b, 2013a,b, 2014, 2016; Bergemann & al. 2013). Here we describe and illustrate two unusual new species from Australia: *Clitopiloides prati* and *Trichopilus lecythiformis*.

Materials & methods

Macro- & micromorphology

Colors were identified subjectively and coded according to Kornerup & Wanscher (1978) with color plates noted in parentheses (E63) in the species description. Common or general names for colors used in this paper are found in the Colour Sample to Colour Name section in the back of the color handbook where each page presents tables flagging technical names for color by * and placing common names in italics; we designate the technical color names using quotation marks (e.g., "Saruk").

Fresh collections were heat dried. Dried basidiomata were sectioned and rehydrated in 3% KOH. A Nikon Eclipse Ci compound microscope with Lumera Infinity 2 imaging software was used to examine and measure microscopic features following Largent (1994). In the taxonomic descriptions $\bar{x}$ = mean dimensions, Q = range of length/width ratios from individual structures, Q_m = mean of all individual length/width ratios, and x/y = the total number of structures measured (x) and the total number of collections examined (y). Specimens were deposited in the Plant Pathology Herbarium, Orange Agricultural Institute, Orange, New South Wales, Australia (DAR); or the Fungarium, Biology Department, Humboldt State University, Arcata, California, USA (HSC).

DNA sequences

Dried basidiomata were pulverized and DNA extracted according to Largent & al. (2011a,b). The ITS region (ITS1, 5.8S and ITS2) of the nuclear ribosomal RNA repeat (nrITS) was amplified with primers ITS1F (Gardes & Bruns 1993) and ITS4 (White Q al. 1990) and the nuclear large subunit (nrLSU) was amplified with primers ctb6 and tw13 (White & al. 1990). PCR reactions of the nrITS and nrLSU were performed in 50 μ L reactions following the procedure as outlined in Largent & al. (2011b) and PCR cycling followed the protocol detailed in Bergemann & Garbelotto (2006). PCR products were cleaned using 1 μ L of ExoSAP-IT (GE Healthcare) and incubated at 37 °C for 15 min followed by 80 °C for 45 min. Cycle sequencing was performed at MCLAB (South San Francisco CA) using an

ABI3730XL sequencer to obtain bi-directional sequences. Contigs were assembled and edited with Sequencher 4.8.

Taxonomy

Clitopiloides prati Largent, sp. nov.

FIG. 1

IF 558177

Differs from *Entoloma cyathus* by its greyish brown, appressed fibrillose pileus, equal stipe, encrusting pigments, pileipellis with erect to suberect distal cells, longer cheilocystidia, ammonia-like odor, and habitat in a lawn.

TYPE: Australia, Queensland, Cook Region, Smithfield, 10 Marcia Close, 16.8261°S 145.6857°E, gregarious in lawn, 27 September 2010, Peter Newling 40a (Holotype HSC A1429); GenBank MW520128, MW520127)

ETYMOLOGY—the genitive of the Latin *partum*, referring to the habitat in a lawn.

BASIDIOMATA clitocyboid. PILEUS 30–70 mm broad, ≤ 25 mm high, plano-convex to plane, deeply depressed to infundibuliform; radially appressed-fibrillose at all times; typically with a metallic luster when fresh; at first greyish brown (6E2, “Saruk”) fading with age to greyish brown to brown (6E3–4) with the disc area remaining greyish brown; not hygrophanous nor translucent-striate; margin incurved becoming plane, entire then eroded; CONTEXT white to off-white, thickness not measured. LAMELLAE ≤ 30 mm long, 7–10 mm broad; white at first, flesh colored with spore maturation; uncinulate with a decurrent tooth or subdecurrent to decurrent; close; edges smooth then eroded, not denticulate; wavy, concolorous; lamellulae 4–7 mm high, 4–15 mm long. STIPE $\leq 60 \times \leq 14$ mm, equal; white becoming at the base faintly brownish with handling and age; longitudinally appressed fibrillose; BASAL TOMENTUM absent. ODOR strong, ammonia-like when crushed. TASTE not taken.

BASIDIOSPORES 5 to (rarely) 6 distinct angles in profile and side views, very rarely 4-angled in polar view; in profile view isodiametric to nearly heterodiametric, on average subisodiametric; apex acute, obtuse, or flat; $6.9\text{--}8.8 \times 5.6\text{--}7.6 \mu\text{m}$ ($x = 8.0 \pm 0.34 \times 6.8 \pm 0.4 \mu\text{m}$; $Q = 1.04\text{--}1.4$; $Q_m = 1.2 \pm 0.1$; $x/y = 64/2$). BASIDIA clavate, tapered to a narrow or moderately broad base, granules abundant but obscure, $26.6\text{--}39.9 \times 9.9\text{--}12.0 \mu\text{m}$ ($x = 33. \pm 3.4 \times 11.0 \pm 0.65 \mu\text{m}$; $Q = 2.6\text{--}3.6$; $Q_m = 2.6 \pm 0.3$; $x/y = 22/2$); 4-sterigmate, sterigma $1.2\text{--}5.8 \mu\text{m}$ long. LAMELLAR EDGE partially sterile. CHEILOCYSTIDIA abundant, but often not on every lamella; appear as terminal cells of tramal hyphae, versiform in shape (clavate, broadly cylindro-clavate, cylindro-clavate, rarely vesiculose, sometimes fusiform), short to long, at times at the end of a long stalk; colorless; $27.6\text{--}104.7 \times 6.7\text{--}28.6 \mu\text{m}$ ($x = 53.8 \pm 16.2 \times 13.7 \pm 4.0 \mu\text{m}$;

$Q = 1.8\text{--}9.4$; $Q_m = 4.2 \pm 1.7$; $x/y = 61/2$). PLEUROCYSTIDIA absent. LAMELLAR TRAMA when sectioned distinct and $20\text{--}30\ \mu\text{m}$ deep, with the mediostratum composed of subparallel, longitudinally entangled, dark colored hyphae bordered by two subhymenia of entangled, colorless, narrow hyphae with non-gelatinized walls; in squash mounts hyphae narrow to very broad and with both ends rounded, $59.8\text{--}451.0 \times 2.3\text{--}23.2\ \mu\text{m}$ ($x = 202 \pm 110.6 \times 10.3 \pm 5.1\ \mu\text{m}$; $Q = 6.1\text{--}54.2$; $Q_m = 22.4 \pm 12.4$; $x/y = 26/2$). PILEIPELLIS $\sim 80\ \mu\text{m}$ deep, a tightly entangled layer of narrow hyphae with distal 1–4 cells erect to suberect; PILEOCYSTIDIA narrowly clavate to cylindric, $23.4\text{--}79.0 \times 3.0\text{--}12.8\ \mu\text{m}$ ($x = 44.6 \pm 15.7 \times 7.6 \pm 2.3\ \mu\text{m}$; $Q = 2.0\text{--}10.6$; $Q_m = 6.3 \pm 2.4$; $x/y = 27/2$). PILEAL TRAMAL HYPHAE in squash sections with distal cells with narrow to broadly acuminate ends, $67.8\text{--}261.0 \times 8.8\text{--}30.6\ \mu\text{m}$ ($x = 173.8 \pm 67.4 \times 16.3 \pm 7.2\ \mu\text{m}$; $Q_m = 12.0 \pm 5.2$; $x/y = 11/2$). STIPITIPPELLIS at the apex $33.0\text{--}62.3\ \mu\text{m}$ deep, an entangled layer of hyphae with erect, suberect, or prostrate distal cells; CAULOCYSTIDIA clavate to cylindric, $20.5\text{--}91.4 \times 4.1\text{--}10.8\ \mu\text{m}$ ($x = 49.4 \pm 18.2 \times 6.7 \pm 1.7\ \mu\text{m}$; $Q = 4.4\text{--}12.7$; $Q = 7.7 \pm 3.0$; $x/y = 23/2$). STIPE TRAMAL HYPHAE in longitudinal sections subparallel and entangled, $103\text{--}405 \times 6.9\text{--}36.8\ \mu\text{m}$ ($x = 245.2 \pm 91.0 \times 18.6 \pm 8.2\ \mu\text{m}$; $Q = 6.9\text{--}25.9$; $Q_m = 14.4 \pm 5.2$; $x/y = 20/2$). OLEIFEROUS HYPHAE absent in all tramal tissues. LIPID GLOBULES absent. PIGMENTATION slightly to definitely encrusting on lamellar and pileus tramal hyphae; uniform, cytoplasmic, and light brownish in pileocystidia. CLAMP CONNECTIONS absent in the pileipellis, typically absent at base of basidia and cheilocystidia, and absent on the hyphae of the pileipellis.

ECOLOGY & DISTRIBUTION—Gregarious, broadcast over a $10 \times 4\ \text{m}$ area in a lawn. Spring; early to late September. Known only from type locality.

ADDITIONAL SPECIMEN EXAMINED—AUSTRALIA, QUEENSLAND, Cook Region, Smithfield, 10 Marcia Close, $16.8261^\circ\text{S } 145.6857^\circ\text{E}$, gregarious in lawn, 9 September 2010, *Topotype* Peter Newling

DISTINCTIVE CHARACTERS—Clitocyboid basidiomata with deeply depressed to infundibuliform radially appressed-fibrillose greyish brown pilei that have a metallic luster when fresh, subdecurrent to decurrent close lamellae, an equal stipe that becomes brownish when handled, a strong ammoniac odor, and a lawn habitat. Microscopically distinguished by subisodiametric distinctly angular basidiospores ($x = 9 \times 7\ \mu\text{m}$), versiform often long-stalked cheilocystidia, a pileipellis $\sim 80\ \mu\text{m}$ deep with a tightly entangled layer of narrow hyphae with the distal 1–4 cells erect to suberect, cytoplasmic pigmentation in the pileocystidia and encrusting pigment on the walls of the pileal and lamellar tramal hyphae and the presence of caulocystidia.



Fig. 1. *Clitopiloides prati* (holotype HSC A1429; except B): A. basidioma with deeply depressed to nearly infundibuliform pileus; B. (Topotype HSC A1430) overly mature basidiomata with infundibuliform pileus; C. 5-angled basidiospores; D. clavate sterigmate basidium tapered to narrow base; E. cluster of broadly clavate to cylindro-clavate cheilocystidia; F. tightly entangled stipitipellis ~2.4 cm down stipe apex, with semi-erect to prostrate caulocystidia; G. pileipellis from disc with loosely entangled hyphal layer with semi-erect cylindro-clavate pileocystidia. Scale bars: A, B = 14 mm; C = 8 μ m; D = 33 μ m; E = 15 μ m; F = 50 μ m; G = 50 μ m.

COMMENTS—*Clitopiloides prati* morphologically resembles *C. cyathus* (Romagn. & Gilles) Largent from Gabon and the Ivory Coast in its brownish colored basidiomata, deeply depressed to infundibuliform pileus, decurrent lamellae, presence of cheilocystidia, and 5–6-angled basidiospores measuring $7\text{--}9 \times 5.7\text{--}7.6 \mu\text{m}$. However, *C. cyathus* is distinguished by its yellowish brown (“bistre”) glabrous, translucent-striate, hygrophanous pileus, denticulated lamellae, clavate stipe, lack of odor or an odor of bitter almonds, cheilocystidia measuring $25\text{--}45 \times (8.5\text{--})12\text{--}16(\text{--}24) \mu\text{m}$, vacuolar pigmentation, and rainforest habitat (Romagn. & Gilles, 1979). *Entoloma cuboidosporum* (Beeli) E. Horak from Malaysia, Singapore, Zaire, Madagascar, Gabon, and the Congo shares the brownish, deeply depressed to infundibuliform pileus and decurrent lamellae found in *C. prati* but differs in its glabrous pileus, farinaceous odor, and cuboid basidiospores (Horak, 1980).

GenBank’s Blastn tool shows the ITS sequence from *C. prati* as 88.63% similar to *Entoloma subclitocyboides* W.M. Zhang (= *E. subinfundibuliforme* T.H. Li & Chuan H. Li) from China. *Entoloma subclitocyboides* differs from *C. prati* in its broader ($7.0\text{--}8.5 \mu\text{m}$) isodiametric basidiospores, dirty yellowish to pale yellow brown pileus, adnexed subventricose lamellae, lack of odor, lack of encrusting pigments in the lamellar trama and pileipellis, presence of clamp connections, and habit on soil in mixed forest (He & al. 2014).

***Trichopilus lecythiformis* Largent, sp. nov.**

FIG. 2

IF 558178

Differs from *Trichopilus tibiiformis* by its yellowish brown, translucent striate pileus, a stipe that bruises yellow brown, larger basidiospores, and abundant lecythiform cheilocystidia and pleurocystidia.

TYPE: Australia, New South Wales, North Coast, Myall Lakes National Park, Mungo Brush campground $32.5457^{\circ}\text{S } 152.3094^{\circ}\text{E}$, 30 April 2012, DL Largent 10482 (Holotype, DAR 81840).

ETYMOLOGY—*lecythiformis* (Latin) referring to the lecythiform cheilocystidia.

BASIDIOMATA omphalinoid. PILEUS 13–14 mm broad $\times$ 1.0–1.5 mm tall, convex to plano-convex, shallowly depressed, tomentulose on the disc, glabrous elsewhere; dark yellowish brown (5F4 “sepia brown”) in center at all times, elsewhere light yellowish brown (5E4 “hair brown”) becoming darker with age and drying (5F7 “coffee”), margin decurved then plane, very slightly crenulate, translucent striate to the disc, moist and wet, not hygrophanous. LAMELLAE 6 mm long $\times$ 2–2.5 mm high, adnate to short decurrent at first, then long decurrent, at first off-white to orange white (5A4), becoming pale orange (5B3) with sporulation, narrow then distant, edge smooth and concolorous;

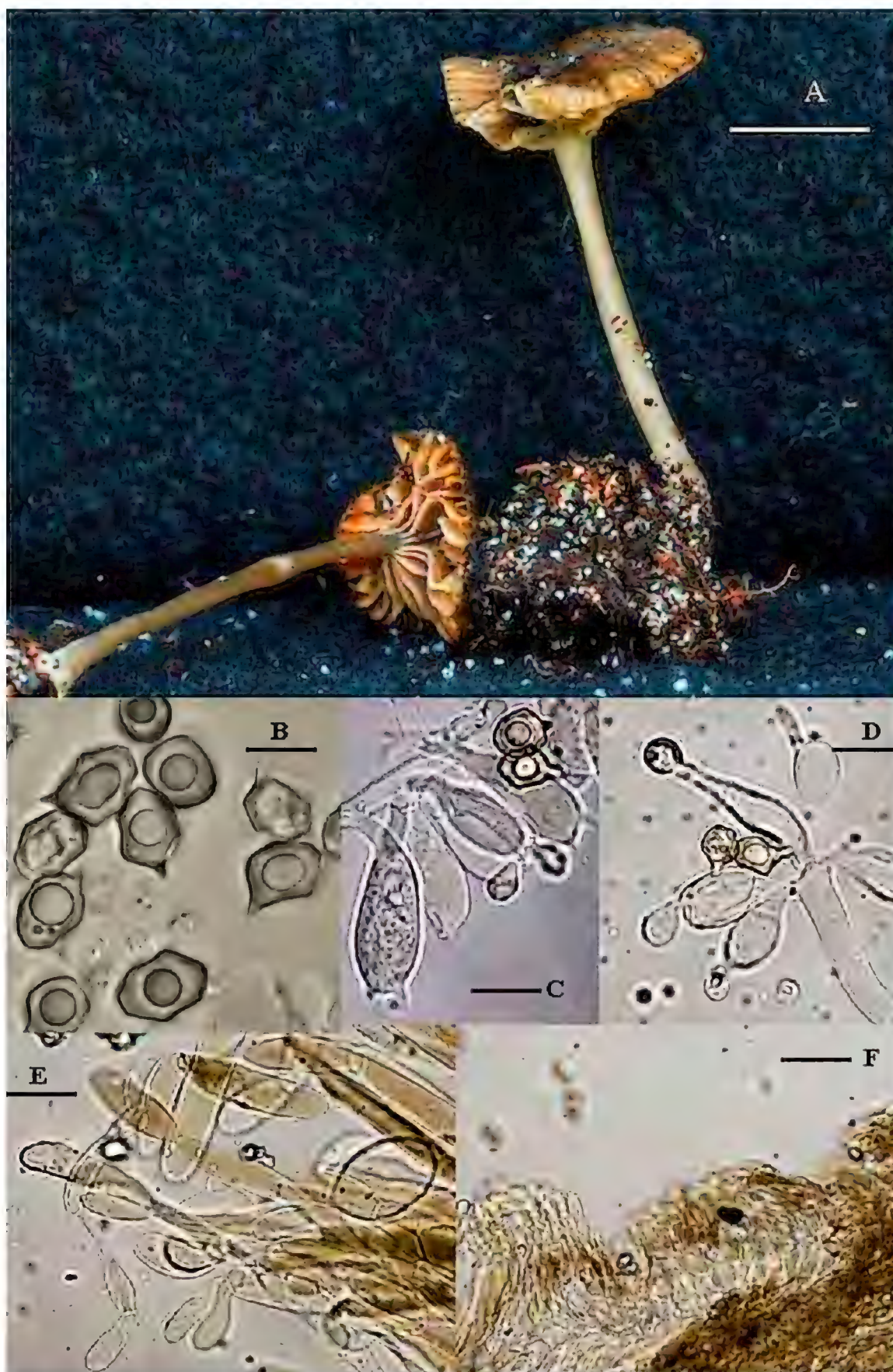


Fig. 2. *Trichopilus lecythiformis*. (holotype DAR 81840): A. basidiomata; B. 6-angled basidiospores in profile view; C. clavate sterigmate basidia tapered to narrow bases; D. tibiiform and lecythiform cheilocystidia; E. clavate pileocystidia with plasmatic brown pigments; F. disc pileipellis showing loosely entangled palisadoderm. Scale bars: A = 14 mm; B = 8 µm; C = 12 µm; D = 14 µm; E = 13 µm; G = 55 µm.

lamellae 2–3 between lamellae, in 2 series (one short, one medium long). STIPE 22–28 × 1.0–1.5 mm, straight, equal, faintly pruinose at the apex, elsewhere glabrous, yellowish white (4A2) to light yellowish grey (5B2 “putty”), bruising yellowish brown (~5E5 “bronze” = “bronze brown”); BASAL TOMENTUM absent. ODOR and TASTE mild, not distinctive.

BASIDIOSPORES 5–6-angled, angles distinct, hilar appendage large and distinct, apex rarely acute, often obtuse, nearly all spores with single globule, on average heterodiametric, 9.8–14.4 × 6.8–9.9 μm ($x = 11.3 \pm 1.0 \times 8.3 \pm 0.67 \mu\text{m}$; $Q = 1.19\text{--}1.55$; $Q_m = 1.35 \pm 0.10$; $x/y = 53/1$). BASIDIA clavate, narrowly tapered at the very base (7/8 inflated), with granules that are not brilliant; 23.0–36.1 × 11.2–13.8 μm ($x = 29.3 \pm 2.9 \times 12.4 \pm 0.85 \mu\text{m}$; $Q = 1.80\text{--}2.76$; $Q_m = 2.38 \pm 0.26$; $x/y = 16/1$); 4-sterigmate, sterigma 2.52–5.79 μm . CHEILOCYSTIDIA abundant, lamellar edge mostly sterile, tibiiform and lecythiform, colorless, 29.7–57.0 × 10.2–17.4 μm ($x = 46.7 \pm 7.8 \times 14.2 \pm 1.5 \mu\text{m}$; $Q = 2.5\text{--}4.0$; $Q_m = 3.29 \pm 0.45$; $x/y = 19/1$); head 4.0–9.0 μm wide ($x/y = 21/1$); neck 2.4–6.2 μm wide ($x/y = 21/1$). PLEUROCYSTIDIA rare at the lamellar edge, similar in shape and size to cheilocystidia. LAMELLAR TRAMAL HYPHAE subparallel and in squash mounts rounded at both ends, 55.3–100.9 × 12.2–20.6 μm ($x = 78.8 \pm 13.9 \times 15.1 \pm 3.1 \mu\text{m}$; $Q = 3.50\text{--}6.75$; $Q_m = 5.35 \pm 1.13$; $x/y = 7/1$). PILEIPELLIS on the disc a distinct palisadoderm with erect hyphal elements attached laterally, distal 4–5 cells inflated, prostrate from the pileus middle to margin; pileocystidia clavate to cylindro-clavate, 27.1–109.3 × 8.25–18.8 μm ($x = 56.7 \pm 20.4 \times 13.9 \pm 2.7 \mu\text{m}$; $Q = 2.62\text{--}8.11$; $Q_m = 4.44 \pm 1.44$; $x/y = 38/1$). PILEAL TRAMAL HYPHAE subparallel and entangled, 30.8–56.0 × 5.7–9.5 μm ($x = 47.0 \pm 8.9 \times 8.6 \pm 1.5 \mu\text{m}$; $Q = 3.41\text{--}8.80$; $Q = 5.66 \pm 1.78$; $x/y = 6/1$). STIPITPELLIS a cutis; CAULOCYSTIDIA absent. STIPE TRAMAL HYPHAE in longitudinal section, subparallel and entangled; 55.6–273.3 × 7.4–28.5 μm ($x = 155.4 \pm 59.3 \times 15.2 \pm 5.0 \mu\text{m}$; $Q = 4.83\text{--}19.40$; $Q_m = 10.74 \pm 4.35$; $x/y = 15/1$). OLEIFEROUS HYPHAE absent in all tramal tissues. LIPID GLOBULES absent. PIGMENTATION cytoplasmic, uniform, brown in apical cells of the pileipellis, encrusted in the basal cells; basidia containing non-brilliant granules. CLAMP CONNECTIONS absent.

ECOLOGY & DISTRIBUTION– Scattered in grass along the beach track, Myall Lakes National Park, coastal New South Wales, Australia, in late April (autumn). Known only from the type locality.

COMMENTS–*Trichopilus lecythiformis* is known from a single collection of a single basidiome from sandy soil in Myall Lakes National Park in late April. However, this species is distinct from all other Australian entolomatoid fungi due to its combination of small delicate basidiomata, pileus with a

yellowish brown disc, long clavate to cylindro-clavate pileocystidia, 5–6-sided basidiospores measuring $\sim 11.3 \times 8.3 \mu\text{m}$, tibiiform to lecythiform colorless cheilocystidia and pleurocystidia, palisadoderm pileipellis, and the absence of caulocystidia and clamp connections. As far as I know, this the first report of a *Trichopilus* species in Australia with a small delicate basidiome.

Seven other species might be confused with *T. lecythiformis* due to their small delicate basidiomata and tibiiform/lecythiform cheilocystidia. They can be distinguished from *T. lecythiformis* as follows: *T. tibiiformis* Largent & Aime from Guyana has a dark violet brown shaggy, opaque pileus and smaller ($7.6\text{--}9.8 \times 4.5\text{--}6.7 \mu\text{m}$) 6–7-angled basidiospores (Aime & Largent 2010). *Entoloma mariae* G. Stev. from New Zealand has smaller ($9\text{--}11 \times 7\text{--}8.5 \mu\text{m}$) basidiospores, larger ($35\text{--}100 \times 10\text{--}22 \mu\text{m}$) cheilocystidia, a pruinose stipe, and clamp connections; *E. perplexum* E. Horak, also from New Zealand, has a brownish grey small (5–10 mm diam) pileus, cinnamon-colored young lamellae, a pileipellis composed of vesiculose or clavate capitate pileocystidia, a weak farinaceous taste and odor, and 5–6-angled basidiospores measuring $10\text{--}13 \times 7\text{--}9 \mu\text{m}$ (Horak 2008). *Entoloma festivum* Noordel. & al. from the Netherlands has a warm reddish brown hygrophanous pileus with a black disc, smaller ($8.5\text{--}10.5 \times 5.5\text{--}7.5 \mu\text{m}$) 5–8-angled basidiospores, cheilocystidia with a vacuolar pigment, and clamp connections (Noordel. & al. 2010). *Rhodophyllus capitatus* Romagn. & Gilles has a pinkish white, scaly, translucent striate pileus, pale brownish lamellae, smaller ($7\text{--}8.5 \times 5.7\text{--}6.7 \mu\text{m}$) 4–5-angled prismatic basidiospores; *R. applanatus* Romagn. & Gilles has a fairly dark pinkish brown, translucent-striate scaly pileus, smaller ($7\text{--}8.5 \times 5.7\text{--}6.7 \mu\text{m}$) 5–6-angled basidiospores; and *R. lepiotoides* Romagn. & Gilles has a yellow brown opaque pileus with a brown disc and slight umbo and smaller ($6.5\text{--}7.5 \times 5.7\text{--}6.5 \mu\text{m}$) 4–5-angled basidiospores (Romagn. & Gilles 1979). In the literature cited above, there has only been one collection studied for five of these species and two collections for *R. lepiotoides*, suggesting that these species are either rare or the small basidiomata overlooked in the field.

Unfortunately, because all attempts at obtaining DNA sequences from DLL 10482 (the holotype of *T. lecythiformis*) were unsuccessful, this collection is proposed as a *Trichopilus* species based on morphology alone. However, phylogenetic analyses using four genes demonstrated that *Trichopilus* is a statistically supported genus with bootstrap values of 100%/1 representing a monophyletic group nested deep within the Inocephalus–Cyanula clade. Sequences for all four genes (mtSSU, nLSU, rrp2, and tef1) were obtained from *T. tibiiformis* with delicate basidiomata in this study (Karstedt & al. 2019).

We are confident that if sequences are obtained from future collections of *T. lecythiformis*, the species will cluster in this well-supported group.

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Literature cited

- Aime MC, Largent DL, Henkel TW, Baroni TJ. 2010. The *Entolomataceae* of Pakaraima Mountains of Guyana IV: new species of *Calliderma*, *Paraeccilia* and *Trichopilus*. *Mycologia* 102: 633–649. <https://doi.org/10.3852/09-162>
- Bergemann SE, Garbelotto M. 2006. High diversity of fungi recovered from the roots of mature tanoak (*Lithocarpus densiflorus*) in northern California. *Canadian Journal of Botany* 84:1380–1394. <https://doi.org/10.1139/b06-097>
- Bergemann SE, Largent DL, Abell-Davis SB. 2013. *Entocybe haastii* from Watagans National Park, New South Wales, Australia. *Mycotaxon* 126: 61–70. <https://doi.org/10.5248/126.61>
- Gardes M, Bruns TD. 1993. ITS primers with enhanced specificity of basidiomycetes – application to the identification of mycorrhizae and rusts. *Molecular Ecology* 2: 113–118. <https://doi.org/10.1111/j.1365-294X.1993.tb00005.x>
- He XL, Li TH, Peng WH, Gan BC. 2014. A taxonomic revision of *Entoloma clitocyboides* and *E. subinfundibuliforme* from Hainan Island, South China. *Mycoscience* 55: 103–107. <https://doi.org/10.1016/j.myc.2013.06.002>
- He XL, Horak E, Wang D, Li TH, Peng WH, Gan BC. 2019. Descriptions of five new species in *Entoloma* subgenus *Claudopus* from China, with molecular phylogeny of *Entoloma* s.l. *MycoKeys* 61: 1–26. <https://doi.org/10.3897/mycokeys.61.46446>
- Horak E. 1980. *Entoloma* (Agaricales) in Indomalaya and Australasia. *Beihefte zur Nova Hedwigia* 65. 352p.
- Horak E. 2008. Agaricales of New Zealand 1: *Pluteaceae* (*Pluteus*, *Volvariella*); *Entolomataceae* (*Claudopus*, *Clitopilus*, *Entoloma*, *Pouzarella*, *Rhodocybe*, *Richoniella*). *Fungal Diversity Research Series* 19. 305p.
- Karstedt F, Capelari M, Baroni TJ, Largent DL, Bergemann SE. 2019. Phylogenetic and morphological analyses of species of the *Entolomataceae* (Agaricales, Basidiomycota) with cuboid basidiospores. *Phytotaxa* 391: 1–27. <https://doi.org/10.11646/phytotaxa.391.1.1>

- Kalichman J, Kirk PM, Matheny PB. 2020. A compendium of generic names of agarics and *Agaricales*. *Taxon* 69(3): 425–447. <https://doi.org/10.1002/taxa.12240>
- Kornerup A, Wanscher JH. 1978. *Methuen handbook of colour* 3rd ed. Richard Clay Ltd: Chichester, Sussex. 252 p.
- Largent DL. 1994. *Entolomatoid fungi of the western United States and Alaska*. Mad River Press Inc: Eureka, California. 516 p.
- Largent DL. 2020. Nomenclature changes in the “Entolomatoid fungi of western North America and Alaska” (Largent 1994). *Mycotaxon* 135: 789–794. <https://doi.org/10.5248/135.789>
- Largent DL, Abell-Davis S. 2011 Observations on *Inocephalus virescens* comb. nov. and *Alboleptonia stylophora* from northeastern Queensland. *Mycotaxon* 116: 231–245. <https://doi.org/10.5248/116.231>
- Largent DL, Abell-Davis SE, Cummings GA, Ryan KL, Bergemann SE. 2011a. Saxicolous species of *Claudopus* (*Agaricales*, *Entolomataceae*) from Australia. *Mycotaxon* 116: 253–264. <https://doi.org/10.5248/116.253>
- Largent DL, Bergemann SE, Cummings GA, Ryan KL, Abell-Davis SE, Moore S. 2011b. *Pouzarella* (*Agaricales*, *Entolomataceae*) species from New South Wales (Barrington Tops National Park) and northeastern Queensland, Australia. *Mycotaxon* 117: 435–483. <https://doi.org/10.5248/117.435>
- Largent DL, Bergemann SE, Abell-Davis SE, Kluting KL, Cummings GA. 2013a. Three new *Inocephalus* species with cuboid basidiospores from New South Wales and Queensland, Australia. *Mycotaxon* 123: 301–319. <https://doi.org/10.5248/123.301>
- Largent DL, Bergemann SE, Abell-Davis SE, Kluting KL, Cummings GA. 2013b. Five *Leptonia* species from New South Wales and Queensland, Australia. *Mycotaxon* 125: 11–35. <https://doi.org/10.5248/125.11>
- Largent DL, Bergemann SE, Abell-Davis SB. 2014. *Entoloma* species from New South Wales and northeastern Queensland, Australia. *Mycotaxon* 129(2): 329–359. <http://doi.org/10.5248/129.329>
- Largent DL, Kluting KL, Anderson NM, Bergemann SE. 2016. New leptonioid species from New South Wales and northeastern Queensland, Australia. *Mycotaxon* 131: 153–176. <https://doi.org/10.5248/131.153>
- Noordeloos ME. 1992. *Entoloma* s.l. *Fungi Europaei* 5: 1–760.
- Noordeloos ME. 2004. *Entoloma* s.l. *Fungi Europaei* 5a: 761–1378.
- Noordeloos ME, Gates GM. 2012. The *Entolomataceae* of Tasmania. *Fungal Diversity Research Series* 22: 400 p. <https://doi.org/10.1007/978-94-007-4679-4>
- Noordeloos ME, Rommelaars LCAF, Gelderblom JNJ. 2010. *Entoloma festivum*, a new species in subgenus *Trichopilus* from the Netherlands. *Mycotaxon* 111: 495–499. <https://doi.org/10.5248/111.495>
- Romagnesi H. 1978. Les fondements de la taxinomie des rhodophylles et leur classification. (Tirage à part de “Beiheft 59 zur Nova Hedwigia”). J. Cramer, Vaduz. 79 p.
- Romagnesi H, Gilles G. 1979. Les rhodophylles des forêts côtières du Gabon et de la Côte d’Ivoire avec une introduction générale sur la taxinomie du genre. *Beihefte zur Nova Hedwigia* 59. 649 p.
- White TJ, Bruns T, Lee S, Taylor JW. 1990. Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. 315–322, in: MA Innis et al. (eds). *PCR protocols: a guide to methods and applications*. Academic Press, Inc. New York. <http://doi.org/10.1016/B978-0-12-372180-8.50042-1>